Часть 1

Олимпиада: **Физика, 11 класс (1 часть)**

Шифр: **21200077**

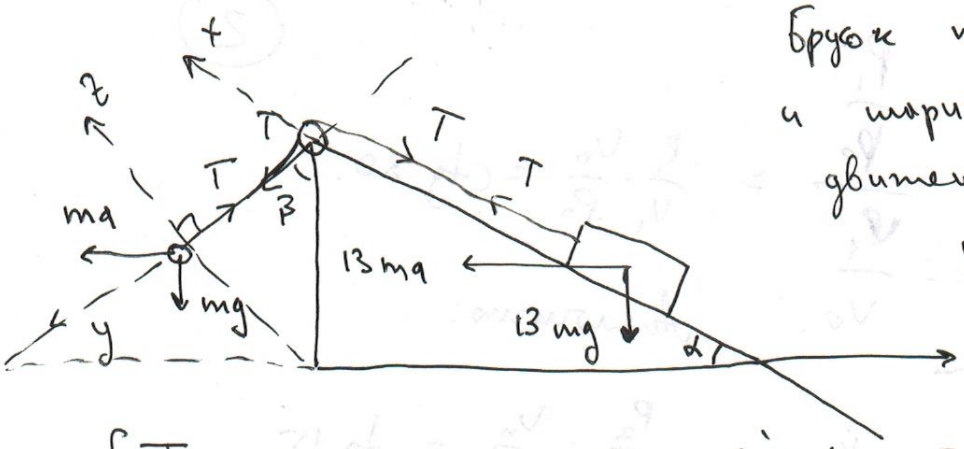
ID профиля: **207134**

Вариант 5

Чистовик. 11-05.

Задача 1

Перейдем в неинерц. с.о, связан. с клином.



Брусок по ox и шарик по oy движется с уск. a_0 т.к. нить нерастяжима ($oz \perp oy$.)

(1)

$$\begin{cases} ox: & T + 13ma\cos\alpha - 13mg\sin\alpha = 13ma_0 \\ oy: & -T + mg\cos\beta + ma\sin\beta = ma_0 \\ oz: & ma\cos\beta = mg\sin\beta \end{cases}$$

+

$$\begin{cases} 13ma\cos\alpha - 13mg\sin\alpha + mg\cos\beta + ma\sin\beta = 14ma_0 \\ a = \frac{3}{4}g \end{cases}$$

1) $\boxed{a = g\,tg\beta = \frac{3}{4}g.}$

$\sin\beta = \frac{3}{5}$

$\sin\alpha = \frac{5}{13}$.

$$13m\cdot\frac{3}{4}g\cdot\frac{12}{13} - 13mg\cdot\frac{5}{13} + mg\cdot\frac{4}{5} + m\cdot\frac{3}{4}g\cdot\frac{3}{5} = 14ma_0$$

$$9mg - 5mg + \frac{4}{5}mg + \frac{9}{20}mg = 14ma_0 \quad | :m.$$

$$\frac{(80+16+9)}{20\cdot 14}\cdot g = a_0 \Leftrightarrow \frac{25\cdot 8}{20\cdot 14}g = a_0$$

2) $\boxed{a_0 = \frac{3}{8}g}$

3) Шарик движется по oy с a_0 равноуск-но:

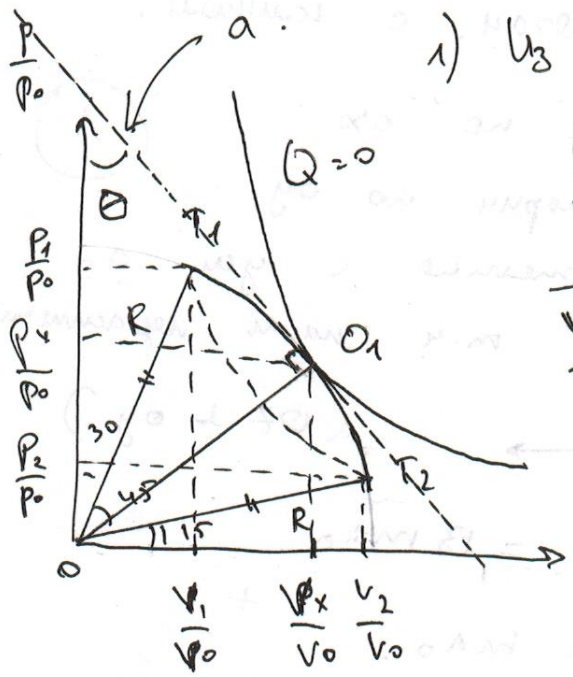
$$\frac{H}{\cos\beta} = \frac{a_0T^2}{2}$$

$$T = \sqrt{\frac{2H}{\cos\beta\, a_0}} = \sqrt{\frac{2H}{\frac{4}{5}\cdot\frac{3}{8}g}} = \sqrt{\frac{20}{3}\frac{H}{g}}$$

Ответ: 1) $\frac{3}{4}g$
2) $\frac{3}{8}g$
3) $\sqrt{\frac{20H}{3g}}$

Чистовик 11-05

Задача 2



1) Из с-ии о-т.1.

(2)

$$\frac{\frac{P_1}{P_0}}{\frac{V_1}{V_0}} = \frac{P_1}{V_1}\cdot\frac{V_0}{P_0} = \operatorname{ctg} 30.$$

Аналогично:

$$\frac{P_2}{V_2}\cdot\frac{V_0}{P_0} = \operatorname{tg} 15.$$

Из ~~равенства~~ отношения проекций

$$\frac{P_1}{P_2} = \frac{R\cos 30}{R\sin 15}; \quad \frac{V_1}{V_2} = \frac{R\sin 30}{R\cos 15}.$$

$$\left.\begin{aligned} P_1V_1 &= \nu RT_1 \\ P_2V_2 &= \nu RT_2 \end{aligned}\right| \Rightarrow 1)\ \frac{T_1}{T_2} = \frac{P_1}{P_2}\cdot\frac{V_1}{V_2} = \frac{\cos 30\sin 30}{\cos 15\sin 15} =$$

$$= \frac{\sin 60}{\sin 30} = \sqrt{3}.$$

2) Теплоемкость равна 0

в точке, где график касается с адиабатой:

на рис т. O_1. $\boxed{\alpha = \frac{c_p}{c_v} = \frac{5}{3}}$, т.к. 1 атомный газ.

$PV^{\alpha} = \text{const}$ $\alpha = \gamma$ В координатах P-V.

$dPV^{\alpha} + dV\alpha V^{\alpha-1}P = 0$ На рис общая касательная

$dPV = -PdV\alpha$. а имеет $\operatorname{tg}\theta_2 = -\frac{P_x}{V_x}\alpha$.

$\frac{dP}{dV} = -\frac{P}{V}\alpha$ θ_2 - угол наклона ~~[illegible]~~;

от 1 а

Чистовик 11-05.

Задача 2 (продолжение 2)

A' найдем, как разн. S сектора и △ OBC

$S_{сек} = \pi R^2 \cdot \frac{1}{8}$ $\angle BOC = 45°$; (4)

$S_{\triangle OBC} = \frac{1}{2} R^2 \sin 45 = \frac{1}{2} R^2 \cdot \frac{\sqrt{2}}{2} = \frac{\sqrt{2}}{4} R^2$

$S_{ABCD} = \frac{(R\cos 30 + R\sin 15)(R\cos 15 - R\sin 30)}{2} =$

$= \frac{R^2(\cos 30 + \sin 15)(\cos 15 - \sin 30)}{2}$

$\cos 30 = \frac{1,4}{2} = 0,85$

$\sin 15 = 0,26$

$\cos 15 = 0,96$

$A' = S_{сек} - S_{OBC}$ $\beta = \frac{2A'}{A_{12}} =$

$A_{12} = S_{ABCD} + A'$ $= \frac{2A'}{S_{ABCD} + A'}$

$A' = \left(\frac{3,14}{8} - \frac{1,4}{4}\right) R^2 = 0,04 R^2$

$S_{ABCD} = \frac{R^2}{2}(0,85 + 0,26)(0,96 - 0,5) = \frac{R^2}{2} \cdot 1,11 \cdot 0,46 =$

$= \frac{R^2}{4}$

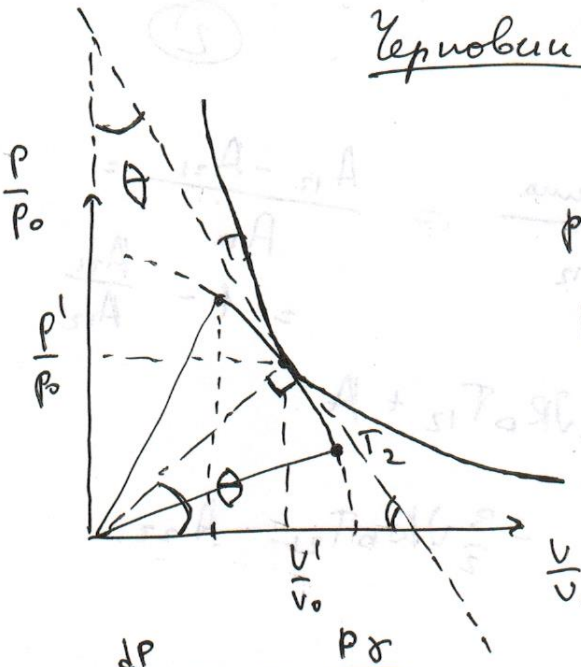
$$\beta = \frac{0,08 R^2}{\frac{R^2}{4}} = 0,32.$$

Ответ:

(1) $\frac{T_1}{T_2} = \sqrt{3}$ (2) $\theta = \operatorname{arctg}\sqrt{\frac{1}{5}}$

(3) $\frac{A_{луны}}{A_{12}} = 0,32.$

Черновик



(1)

$PV^{\frac{c_p}{c_v}} = \text{const}.$

$P\,dV\,\gamma V^{\gamma-1} + dP V^{\gamma} = 0.$

$P\,dV\,\gamma = -dP\cdot V$

$P = \frac{\beta}{V^{\gamma}}$

$\frac{dP}{dV} = -\frac{P\gamma}{V}$

$\gamma = \frac{c_p}{c_v} = \frac{\frac{5}{2}R}{\frac{3}{2}R} = \frac{5}{3}$

$ctg\,\theta = +\frac{P'}{V'}\gamma.$

$ctg\,\theta = +5\,tg\,\theta$

$\frac{R\cos\theta}{R\sin 30} = \frac{P'}{P_1}$ $\quad \frac{P_1}{V_1}\cdot\frac{P'}{V'} = \frac{tg\,\theta}{tg\,30}$ $\quad \frac{1}{tg^2\theta} = 5$

$\frac{R\sin\theta}{R\cos 30} = \frac{P'}{P_1}$ $\quad tg\,\theta = \frac{1}{\sqrt{5}}$

$\theta = \text{arctg}\,\frac{1}{\sqrt{5}}$

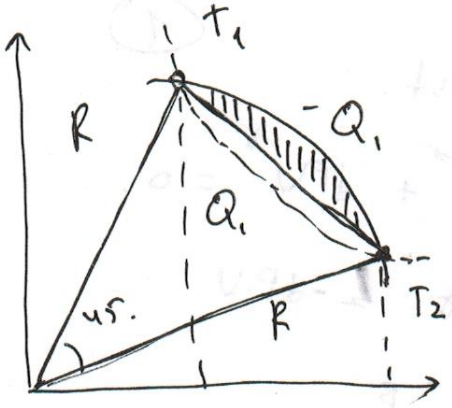
$\Rightarrow$

$\frac{P'V_1}{V'P_1} = \frac{tg\,\theta}{tg\,30}.$

$\frac{P'}{V_1}\cdot\frac{1}{\sqrt{3}} = \frac{tg\,\theta}{\frac{1}{\sqrt{3}}}$ $\quad \frac{P'}{V_1}\cdot\frac{1}{3} = tg\,\theta.$

$\frac{P'}{V'} = 3\,tg\,\theta.$

3) Черновик. (2)



$$\frac{A_{цикла}}{A_{12}} = \frac{A_{12} - A_{21}}{A_{12}} = 1 - \frac{A_{21}}{A_{12}}.$$

$$Q_1 = \frac{3}{2}\nu R \Delta T_{12} + A.$$

$$\Rightarrow Q_1 = -\frac{3}{2}\nu R \Delta T_{21} - A_{23}.$$

$$\frac{T_1}{T_2} = \beta.$$

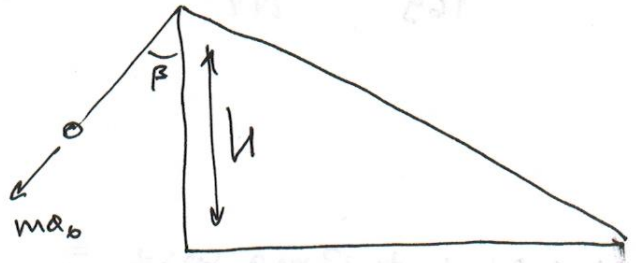
$$A_{12} = A_{тр} + A'$$

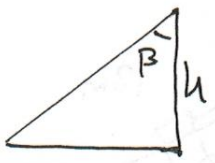
$$A_{21} = A_{тр} - A'$$

$$\Delta A = 2A'$$

Чертежик.

1 атомн.





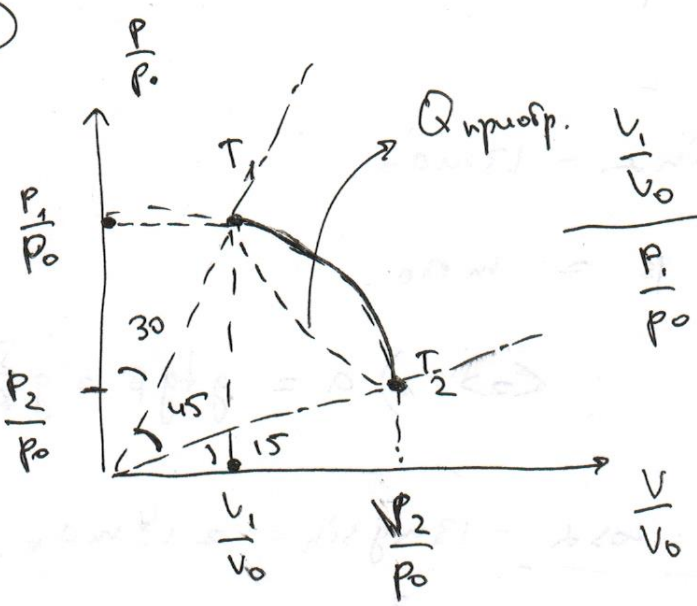
③

$$\frac{H}{\cos\beta} = \frac{a_0 T^2}{2}$$

$$T = \sqrt{\frac{2H}{\cos\beta\, a_0}} = \sqrt{\frac{2H}{\frac{12}{13}\cdot\frac{3}{8}g}} = \sqrt{\frac{4\cdot 13H}{9\cdot g}} =$$

$$= \frac{1}{3}\sqrt{\frac{13H}{g}}$$

②



$$\frac{V_1/V_0}{P_1/P_0} = \frac{V_1}{P_1} = \frac{1}{\sqrt{3}}.$$

$$\frac{P_2}{V_2} = \operatorname{tg} 15.$$

$$P_1V_1 = \nu R T_1$$

$$P_2V_2 = \nu R T_2$$

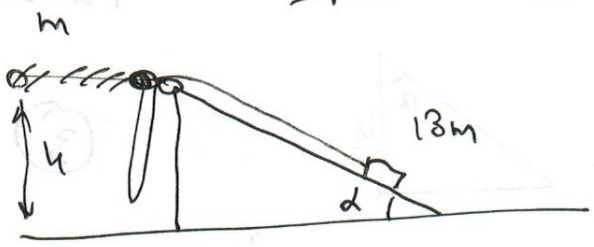
$$\frac{V_1}{V_2} = \frac{R\sin 30}{R\cos 15}.$$

$$\frac{P_1}{P_2} = \frac{R\cos 30}{R\sin 15}.$$

1) $$\frac{T_1}{T_2} = \frac{\sin 30\cos 30}{\sin 15\cos 15} =$$

$$= \frac{\sin 60}{\sin 30} = \frac{\frac{\sqrt{3}}{2}}{\frac{1}{2}} = \sqrt{3}$$

Черновик Вариант 5. (4)



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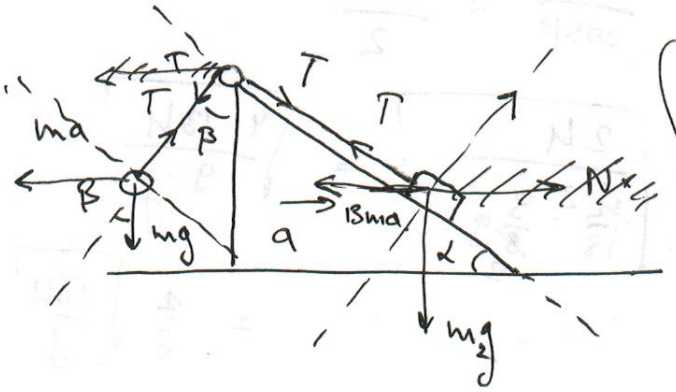


$$\begin{cases} T - m_2 g \sin\alpha + 13ma\cos\alpha = 13ma_0 \\ mg\cos\beta - T = ma_0 \end{cases}$$

$$\begin{cases} T + 13ma\cos\alpha - 13mg\sin\alpha = 13ma_0 \\ -T + mg\cos\beta + ma\sin\beta = ma_0 \\ ma\cos\beta = mg\sin\beta \end{cases} \Leftrightarrow 1)\ a = g\,tg\beta = g\frac{3}{4}.$$

$\sin\beta = \frac{3}{5}$ — $\frac{4}{5}$

$$13m\cdot\frac{3}{4}g\cdot\cos\alpha - 13mg\sin\alpha = 14ma_0.$$
$$+ mg\cos\beta + m\cdot\frac{3}{4}g\sin\beta$$

21·5

$$13m\cdot\frac{3}{4}g\cdot\frac{12}{13} = 9mg$$

$$9mg - 5mg + \frac{4}{5}mg + m\cdot\frac{3}{4}g\cdot\frac{3}{5} = 14ma_0.$$

$$4mg + \frac{4}{5}mg + \frac{9}{20}mg = 14ma_0$$

$$\frac{80+16+9}{20}g = 14a_0 \qquad \frac{105}{20\cdot14} = \frac{21}{4\cdot14} =$$

$$= \frac{3}{8}g$$

$a_0 =$

Чистовик. 11-05.

Задача 2 (продолжение)

угол наклона OO_1 и горизонт $\theta = 90 - \theta_2$

(3)

Аналогично п 1.

Найдем отношение

$$\frac{R\cos\theta}{R\sin 30} = \frac{V_x}{V_1}$$

$$\frac{P_x}{P_1} \text{ и } \frac{V_x}{V_1}:$$

$$\frac{R\sin\theta}{R\cos 30} = \frac{P_0}{P_1}$$

$$\operatorname{ctg}\theta = \frac{P_x}{V_x}\gamma \cdot \frac{V_0}{P_0}.$$

$$\frac{P_1 V_x}{P_x V_1} = \frac{\operatorname{tg}30}{\operatorname{tg}\theta}.$$

$$\frac{1}{\operatorname{tg}\theta} = 5\operatorname{tg}\theta$$

Из п. 1 $\frac{P_1}{V_1}\cdot\frac{V_0}{P_0} = \operatorname{ctg}30.$

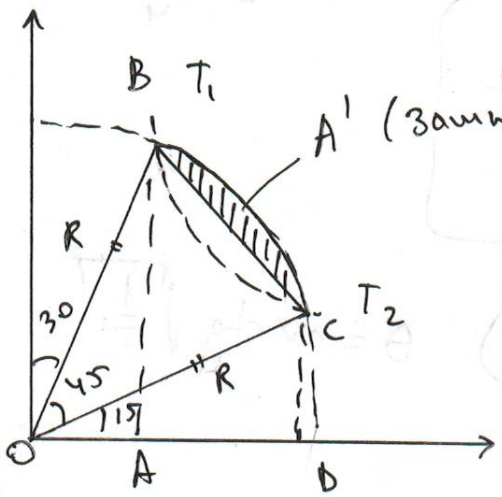
$$\operatorname{tg}^2\theta = \frac{1}{5}$$

$$\frac{P_x}{V_x}\cdot\frac{1}{\sqrt{3}}\cdot\frac{V_0}{P_0} = \frac{\operatorname{tg}\theta}{\frac{1}{\sqrt{3}}}$$

$$\boxed{\theta = \operatorname{arctg}\sqrt{\frac{1}{5}}}$$

$$\frac{P_x}{V_x}\cdot\frac{V_0}{P_0} = 3\operatorname{tg}\theta.$$

3) $\frac{P}{P_0}$



γ мы нашли в п2.

$$A_{12} = \int_{тр\,ABCD} + A'$$

$$A_{21} = \int_{тр\,ABCD} - A'$$

} Т.к. в результате теплообмена вернулись в нач. Т

$$\eta = \frac{A_{цикл}}{A_{12}} \qquad \frac{A_{12} - A_{21}}{A_{12}} = \frac{2A'}{A_{12}}$$

Часть 2

Олимпиада: **Физика, 11 класс (2 часть)**

Шифр: **21200077**

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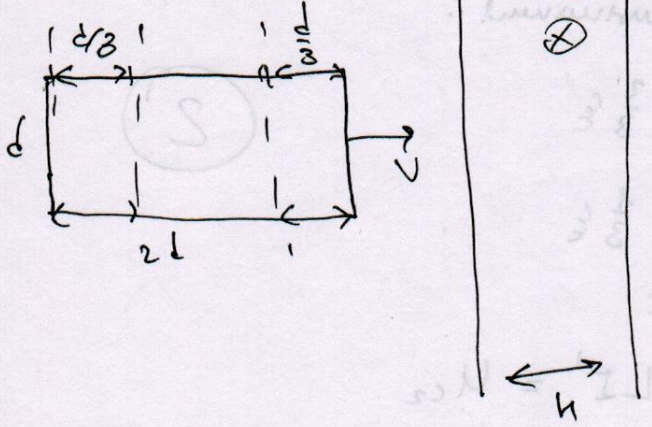
Вариант 5

Чистовик 11-05

Задача 4.



1) $\dot{\Phi} = -\mathcal{E}$ (1)

$\frac{BdS}{dt} = -IR$

$\frac{d \cdot BV \cdot dt}{dt} = -IR$

$I = -\frac{BV \cdot d}{R}$.

$F_A = -ma$

$BIL = ma$.

$L = d$

1) $\boxed{\frac{B^2 d^2 V_0}{Rm} = a}$

2) $\Delta V = \int_0^H a\,dt = \int_0^H \frac{B^2 d^2 dx}{Rm\,dt} \cdot dt = \frac{B^2 d^2 H}{Rm} =$

$= \frac{B^2 d^3}{3Rm}$; $\boxed{V_1 = V_0 - \frac{B^2 d^3}{3Rm}}$.

3) Сначала пока правая сторона пройдет H и в поле, когда левая сторона пройдет H, будет действовать ускорение. $\frac{d}{3} < d$.

Соответственно конечная скорость

$\boxed{V_2 = V_0 - 2\frac{B^2 d^3}{3Rm}}$

Ответ: 1) $\frac{B^2 d^2 V_0}{Rm}$ 2) $V_0 - \frac{B^2 d^3}{3Rm}$ 3) $V_0 - 2\frac{B^2 d^3}{3Rm}$.

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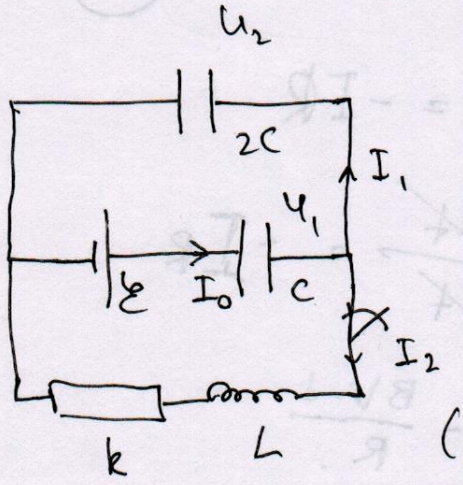
Задача 3.



1) До замыкания:

$U_{C_1} = \frac{2}{3}\mathcal{E}$

$U_{C_2} = \frac{1}{3}\mathcal{E}$

(2)

После:

$RI_R + LI' = U_{C_2}$

(сразу после замыкания $I_R = 0$)

$LI' = \frac{1}{3}\mathcal{E}$; $\boxed{I' = \frac{1}{3}\frac{\mathcal{E}}{L}}$

2) Полностью тепло выделится после установления равновесия: $I_R = 0$;

Ск-но $U_{C_2} = 0$; $U_{C_1} = \mathcal{E}$;

З.С.Э:

$$\frac{2C\cdot\frac{1}{9}\mathcal{E}^2}{2} + \frac{C\cdot\frac{4}{9}\mathcal{E}^2}{2} + \Delta q\,\mathcal{E} = \frac{C\mathcal{E}^2}{2} + Q.$$

$\Delta q = \mathcal{E}C - \frac{2}{3}\mathcal{E}C = \frac{1}{3}\mathcal{E}C$

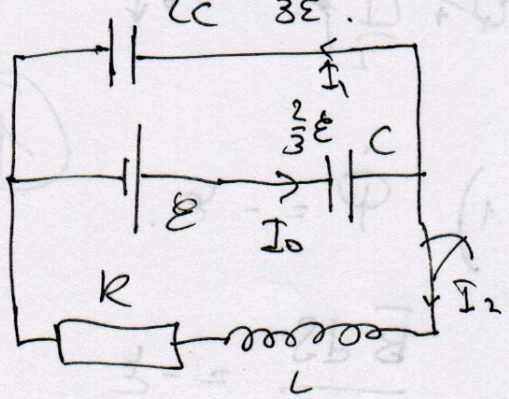
$\frac{1}{3}C\mathcal{E}^2 + \frac{1}{3}C\mathcal{E}^2 - \frac{1}{2}C\mathcal{E}^2 = Q$; $\boxed{Q = \frac{1}{6}C\mathcal{E}^2}$

3) $I_0 = I_1 + I_2$

$I_0 = \frac{CU_1}{\Delta t}$; $I_1 = \frac{2CU_2}{\Delta t} = \frac{2C(\mathcal{E}-U_1)}{\Delta t} = \frac{2C\mathcal{E}}{\Delta t} - 2I_0$

$I_1 = \frac{2C\mathcal{E}}{\Delta t} - 2I_1 - 2I_2$ $\quad 3I_1 = 2\left(\frac{C\mathcal{E}}{\Delta t} - I_2\right)$

Черновик



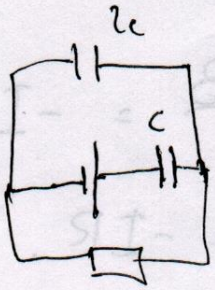
~~$LI' + RI$~~

$LI' + RI = \frac{1}{3}\mathcal{E}$.

$LI' = \frac{1}{3}\mathcal{E}$

1) $I' = \frac{1}{3}\frac{\mathcal{E}}{L}$

2)



$\frac{2C \cdot \frac{1}{9}\mathcal{E}^2}{2} + \frac{C \cdot \frac{4}{9}\mathcal{E}^2}{2} + \Delta q\mathcal{E} =$

$= \frac{C\mathcal{E}^2}{2} + Q.$

$\frac{2}{3}\mathcal{E}C \qquad \mathcal{E}C$

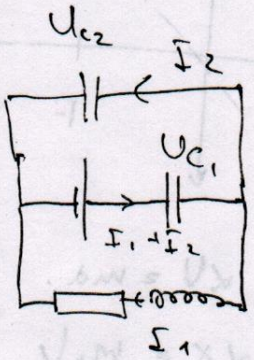
$\Delta q = \frac{1}{3}\mathcal{E}C$

$\frac{1}{9}C\mathcal{E}^2 + \frac{1}{3}\mathcal{E}^2C = \frac{C\mathcal{E}^2}{2} + Q$

$\frac{2}{3}C\mathcal{E}^2 - \frac{C\mathcal{E}^2}{2} = Q.$

$\frac{4}{6}C\mathcal{E}^2 - \frac{3\mathcal{E}^2C}{6} = Q.$

2) $\frac{1}{6}C\mathcal{E}^2 = Q$



$LI_1' + RI_1 + U_{C_1} = \mathcal{E}$

$U_{C2} = \mathcal{E} - U_{C_1}$

$LI_2' + RI_2 + U_{C_1} = \mathcal{E}$

~~$I_1 = I_2$~~

$\mathcal{E} - U_1 = U_2.$

$q_2 = 2CU_{C2}$

$I_2 = \frac{2CU_2}{\Delta t} = \frac{2C(\mathcal{E} - U_1)}{\Delta t}.$

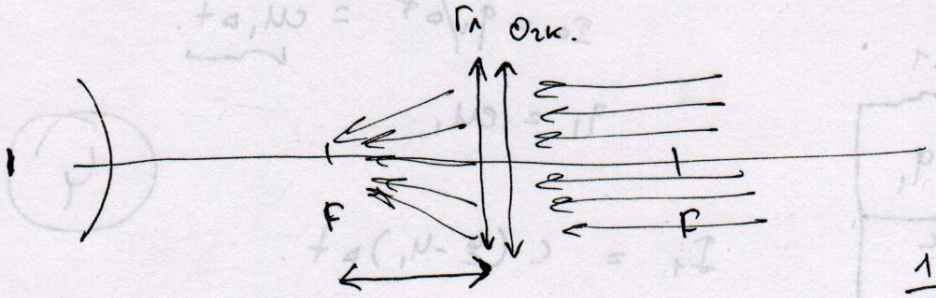
$I_{①} = \frac{CU_{C_1}}{\Delta t} = \frac{CU_1}{\Delta t}.$

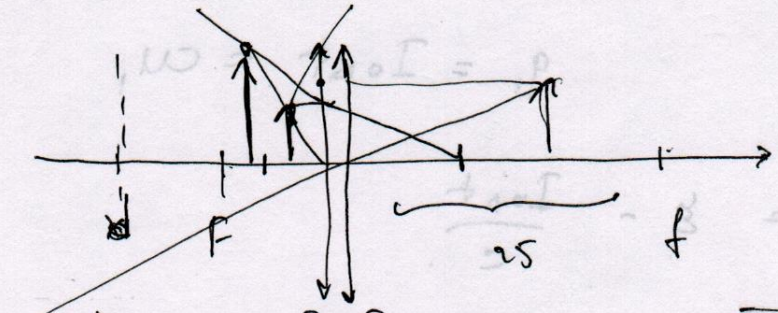
$\frac{2C\mathcal{E}}{\Delta t} - \frac{2CU_1}{\Delta t} = I_2$

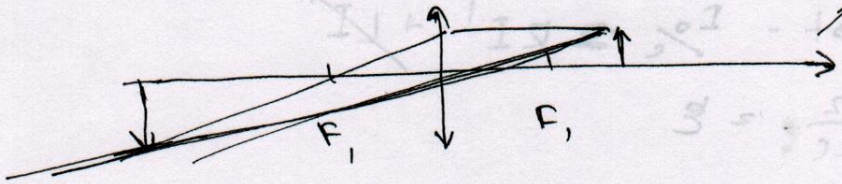
$LI_2 + RI_2 = U_2$

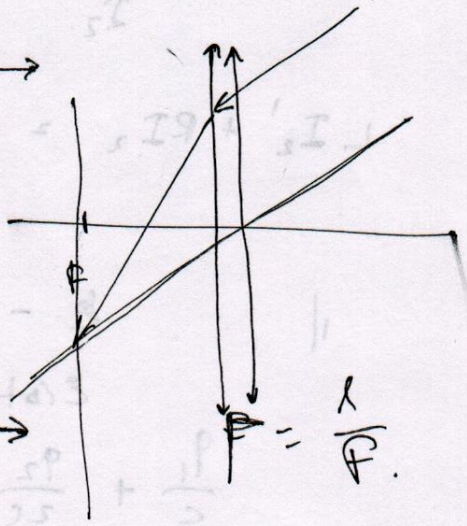
Черновик.

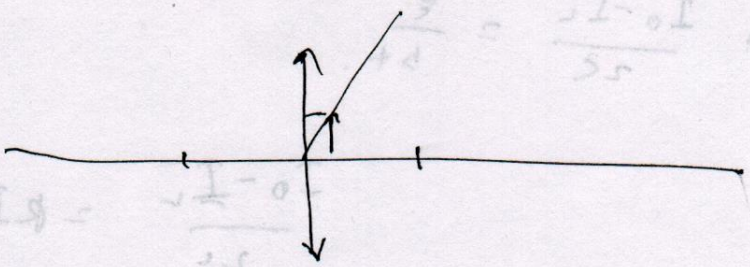
3

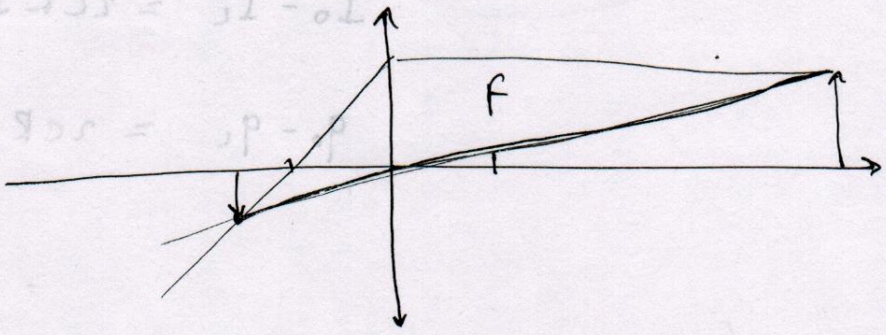


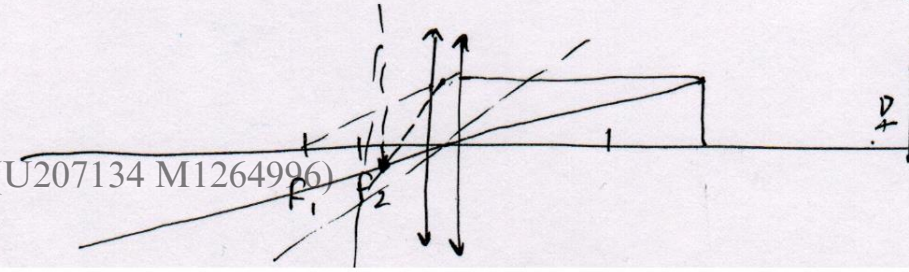












$\frac{1}{F} + \frac{1}{f} = \frac{1}{F_0}$

$C = \frac{1}{F}$.

$LI_2 + RQ_2 = U_2 \Delta t = \mathcal{E} - U_1$

$I = \frac{q}{2c} \Delta t$.

$I_1 = \frac{2CU_2}{\Delta t}$

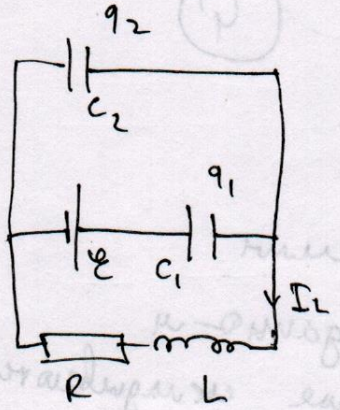
$I_0 = \frac{CU_1}{\Delta t}$

$C \frac{q}{\Delta t} \cdot \Delta t$

Чистовик 11-05.

Задача 3 (профильная)

3



I

q_3 - заряд, который протекает через катушку.

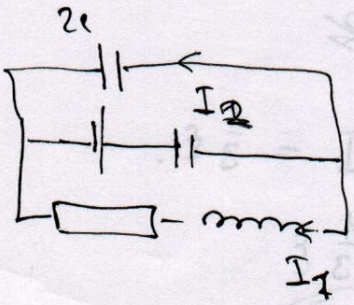
$$\begin{cases} \frac{q_1}{C} + \frac{q_2}{2C} = \mathcal{E} \\ \mathcal{E} - \frac{q_1}{C} = RI_R + LI_L' \end{cases}$$

$$\begin{cases} \frac{I_0}{C} + \frac{I_0 - I_L}{2C} = \frac{\mathcal{E}}{\Delta T} \\ \frac{\mathcal{E}}{\Delta T} - \frac{I_0}{C} = RI_R' + \cancel{LI_L''} \to 0 \end{cases}$$

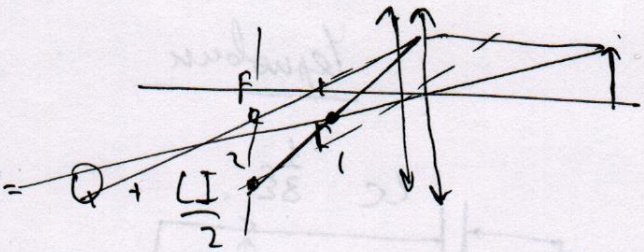
$$\frac{I_0 - I_L}{2C} = RI_R' \quad | \cdot \Delta T$$

$$\frac{q_1 - q_2}{2C} = RI_R = q$$

Черновик



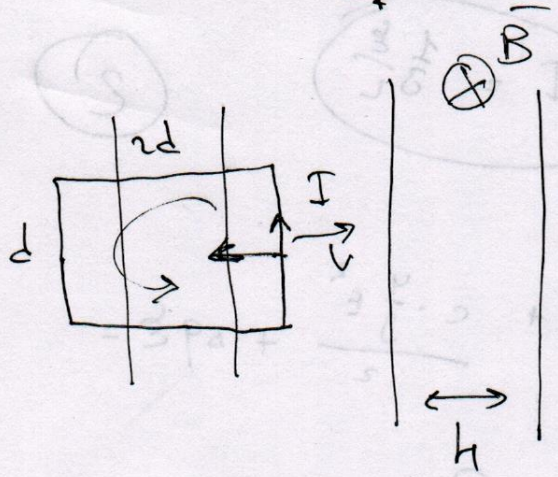
$\frac{2cU^2}{2} = Q + \frac{LI^2}{2}$



1

1) $\dot{\Phi} = -\mathcal{E}$.

4)



$\frac{\bar{B}\,dS}{dt} = -\mathcal{E}$.

$\frac{d \cdot V dt B}{dt} = -IR$.

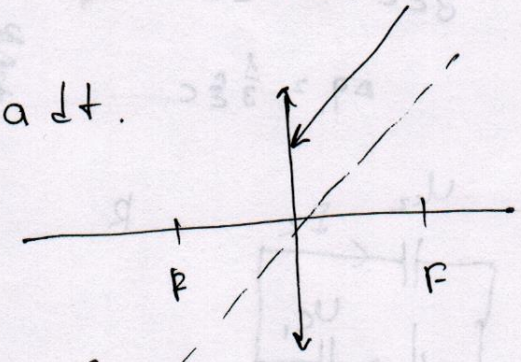
$dVB = -IR$.

$F = BIL = BId = ma$.

$I = \frac{dVB}{R}$.

$\frac{B^2 d^2 V}{Rm} = a$

2) $V - a\,dt$.



$\frac{B^2 d^2 V}{km}\,dt$.

$\Delta V = \int_0^h \frac{Bd^2}{Rm}\,dx = \frac{Bd^2}{Rm} h$

$\alpha V = ma$.

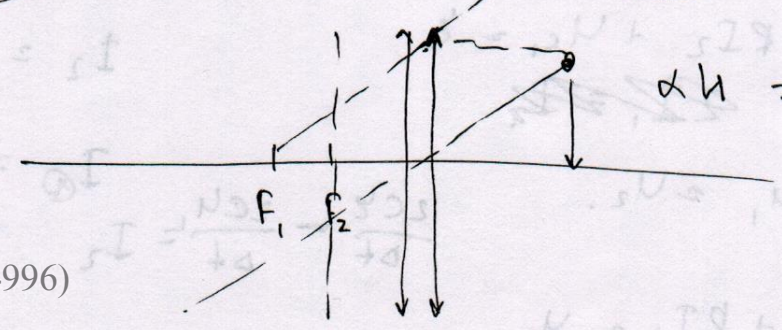
$\alpha x = m_\Delta V$.

$V_1 = V_0 - \frac{B^2 d^2}{Rm} h$

3)

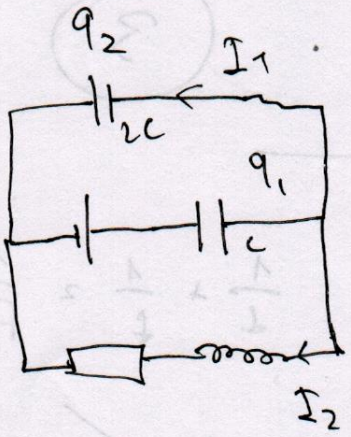
$\frac{\alpha h}{m} = V - V_x$

$h = d/3$



$\alpha h = ma$.

Черновик.



$I_0 = q_1/\Delta t = cu_1 \Delta t.$

$q_1 = cu_1$

(4)

$I_1 = c(\varepsilon - u_1)\Delta t.$

$q_1 = I_0 \Delta t = cu_1$

$L I_2' + R I_2 = \varepsilon - \frac{I_0 \Delta t}{c}.$

$\varepsilon - \frac{q}{c} = RI + LI'$

$\varepsilon/\Delta t - I_0/c = RI' + LI''$

$\frac{q_1}{c} + \frac{q_2}{2c} = \varepsilon$

$\frac{I_0}{c} + \frac{I_0 - I_L}{2c} = \frac{\varepsilon}{\Delta t}.$

$RI_L = U$

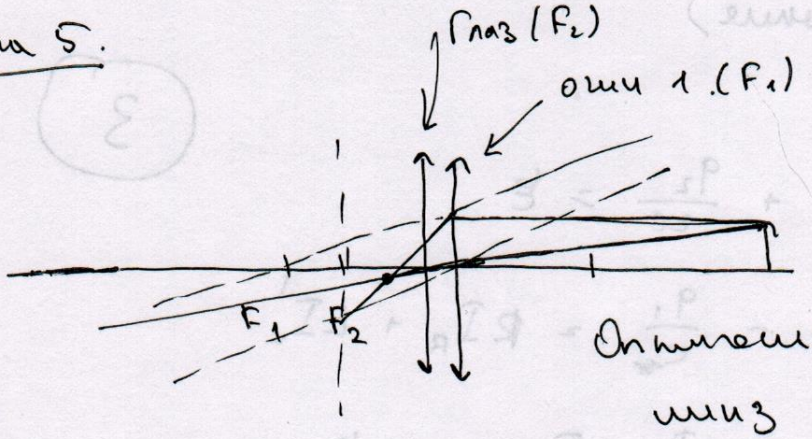
$\frac{I_0 - I_L}{2c} = RI'$

$I_0 - I_L = 2cRI'$

$q_0 - q_L = 2cRI$

Часовник. 11-05.

Задача 5.



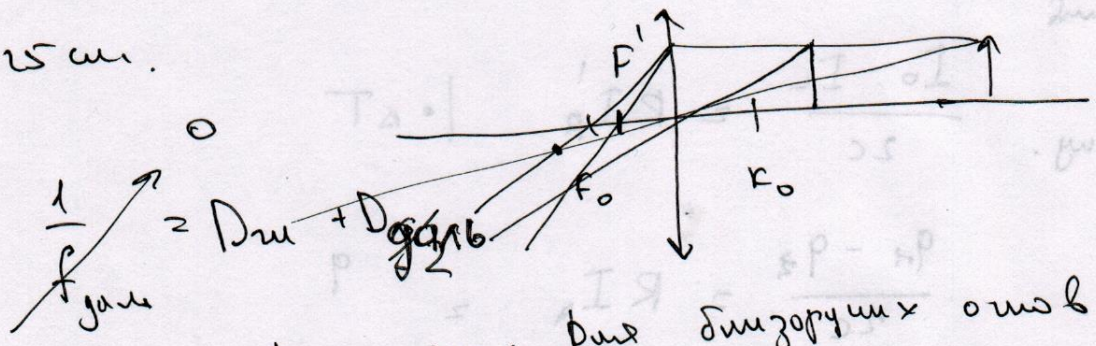
(4)

Оптическая сила линз в данной и другой системах складывается.

$$-\frac{1}{d}+\frac{1}{f}=D_{гл}+D_{бл}.$$

d – расстояние до фокусировки

f = 25 см.



$$-\frac{1}{d}+\frac{1}{f_{дали}}=D_{гл}+D_{дали}$$

$D_{дали}=D_{бл}/2$ для близоруких очков

$F < F_0$ для дали.

сл-но $D_{дали} < D_{близ}$.

$$\frac{1}{f}=\frac{D_{гл}}{2}$$

$$D_{бл}=\frac{2}{f}$$ для дальнозорких очков

$$\boxed{D_{дали}=\frac{1}{f}=\frac{1}{0{,}25}=4}$$ (2)

Ответ: 1) а) $\frac{f}{2}=0{,}12$ м $=12{,}5$ см

б) 4

$$\left.\begin{aligned}-\frac{1}{d}+\frac{1}{0{,}25}&=D_{гл}+8\\ -\frac{1}{d}+\frac{1}{f_x}&=D_{гл}\end{aligned}\right\}\quad 8=\frac{1}{0{,}25}-\frac{1}{f_x}$$

$$f_x=\frac{1}{4}=-0{,}25\text{ м}.$$

Ответ:

2) 16

2) $-\frac{1}{d}+2=D_{гл}+D_{бл}'$.

$D_{бл}'=2D_{бл}=16$